CLAIMS

What is claimed is:

1. An image sensor comprising:

a first micro-lens array comprising first micro-lenses for capturing incoming light;

a second micro-lens array comprising second micro-lenses for focusing incoming light onto photo sensors, wherein the first micro-lens array is positioned above the second micro-lens array and separated from the second micro-lens array by a cavity; and

one or more supports for supporting the first micro-lens array relative to the second micro-lens array.

2. The image sensor of claim 1 wherein said cavity is comprised of air.

3. The image sensor of claim 1 wherein said first micro-lens array is comprised of a first micro-lens material selected from the group consisting of silicon dioxide, silicon nitride, plasma enhanced chemical vapor deposition (PECVD) oxides, interlayer dielectric materials, and BoroPhosphoSilicate Glass (BPSG).

4. The image sensor of claim 1 wherein said second micro-lens array is comprised of a second micro-lens material selected from the group consisting of silicon dioxide, silicon nitride, plasma enhanced chemical vapor deposition (PECVD) oxides, interlayer dielectric materials, and BoroPhosphoSilicate Glass (BPSG).

5. The image sensor of claim 1 wherein said first micro-lenses are concave lenses.

6. The image sensor of claim 5 wherein said second micro-lenses are concave lenses.

7. The image sensor of claim 1 wherein said first micro-lenses are convex lenses.

8. The image sensor of claim 7 wherein said second micro-lenses are convex lenses.

9. The image sensor of claim 1 further comprising a color filter array formed on top of said first micro-lens array.

10. The image sensor of claim 9 further comprising a protective layer positioned on top of the color filter array.

11. The image sensor of claim 3 wherein said one or more supports comprise one or more posts.

12. The image sensor of claim 11 wherein said one or more posts are positioned at one or more edges of the image sensor.

13. The image sensor of claim 11 wherein said one or more posts are positioned internal to edges of the image sensor.

14. The image sensor of claim 13 wherein said one or more posts are comprised of said first micro-lens material.

15. The image sensor of claim 3 wherein said one or more supports are one or more support walls positioned at one or more edges of the image sensor.

16. The image sensor of claim 15 wherein said one or more support walls are comprised of said first micro-lens material.

17. An image sensor comprising:

a substrate having upper substrate layers;

a first micro-lens array comprising first micro-lenses for capturing incoming light, the first micro-lens array being separated from the upper substrate layers by a cavity; and

one or more supports for supporting the first micro-lens array above the upper substrate layers.

18. The image sensor of claim 17 wherein said cavity is comprised of air.

19. The image sensor of claim 17 wherein said first micro-lens array is comprised of a first micro-lens material selected from the group consisting of silicon dioxide, silicon nitride, plasma enhanced chemical vapor deposition (PECVD) oxides, interlayer dielectric materials, and BoroPhosphoSilicate Glass (BPSG).

20. The image sensor of claim 17 further comprising a color filter array positioned above the upper substrate layers and below the first micro-lens layer and wherein said cavity separates the first micro-lens layer from the color filter array.

21. The image sensor of claim 17 wherein said first micro-lenses are concave lenses.

22. The image sensor of claim 17 wherein said first micro-lenses are convex lenses.

23. The image sensor of claim 19 wherein said one or more supports comprise one or more posts.

24. The image sensor of claim 23 wherein said one or more posts are positioned at one or more edges of the image sensor.

25. The image sensor of claim 23 wherein said one or more posts are positioned internal to edges of the image sensor.

26. The image sensor of claim 25 wherein said one or more posts are comprised of said first micro-lens material.

27. The image sensor of claim 19 wherein said one or more supports comprise one or more support walls positioned at one or more edges of the image sensor.

28. The image sensor of claim 27 wherein said one or more support walls is comprised of said first micro-lens material.

29. An imager system comprising:

a processor; and

an image sensor electrically coupled to said processor, said image sensor comprising:

a first micro-lens array having first micro-lenses for capturing incoming light;

a second micro-lens array having second micro-lenses for focusing incoming light onto photo sensors, wherein the first micro-lens array is positioned above the second micro-lens array and separated from the second micro-lens array by a cavity; and

one or more supports for supporting the first micro-lens array relative to the second micro-lens array.

30. An imager system, comprising:

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a processor; and

an image sensor electrically coupled to said processor, said image sensor comprising:

a substrate having upper substrate layers;

a first micro-lens array having first micro-lenses for capturing incoming light,

the first micro-lens array being separated from the upper substrate layers by a cavity; and

one or more supports for supporting the first micro-lens array above relative to the upper substrate layers.

31. A method of fabricating an image sensor, the method comprising:

providing a substrate comprising a plurality of photosensitive regions having photo sensors, and an upper substrate layer;

forming a second micro-lens array having second micro-lenses over the upper substrate layer;

applying a sacrificial material to the second micro-lens array;

forming support molds in the sacrificial material;

forming lens molds in the sacrificial material;

forming supports by filling the support molds with a support material;

forming a first micro-lens array having first micro-lenses by filling the lens molds with a first micro-lens material; and

removing the sacrificial material.

32. The method of claim 31 wherein the step of forming a second micro-lens array further comprises:

applying a second micro-lens material over the upper substrate layer;

applying a lower photo resist to the second micro-lens material;

masking the lower photo resist and exposing openings in the lower photo resist; and

etching the second micro-lens material to form second micro-lenses by applying an chemical etching solution.

33. The method of claim 32 wherein the chemical etching solution is an isotropic etching solution.

34. The method of claim 31 wherein the step of forming the support molds further comprises:

applying a sacrificial photo resist to the sacrificial material;

applying a mask to the sacrificial photo resist and exposing support openings in the sacrificial photo resist; and

etching the sacrificial material by applying an chemical etching solution to form support molds by etching through the support openings.

35. The method of claim 34 wherein the chemical etching solution is an anisotropic etching solution.

36. The method of claim 34 wherein the step of forming the lens molds further comprises:

applying a sacrificial photo resist to the sacrificial material;

applying a mask to the sacrificial photo resist and exposing sacrificial resist openings in the sacrificial photo resist;

etching the sacrificial material by applying a chemical etching solution to form lens molds by etching through the sacrificial resist openings; and

applying a rinse to stop the etching of the sacrificial material.

37. The method of claim 36 wherein the chemical etching solution is an isotropic etching solution.

38. The method of claim 31 wherein the step the forming the support molds further comprises etching the support molds in the sacrificial material by controlled laser etching.

39. The method of claim 31 wherein the step the forming the lens molds further comprises etching the lens molds in the sacrificial material by controlled laser etching.

40. The method of claim 31 wherein said sacrificial material degrades upon heating to a degradation point, and said step of removing the sacrificial material comprises heating the sacrificial material to at least the degradation point.

41. The method of claim 31 further comprising:

forming vacuum channels through the first micro-lens array, wherein the distal ends of the vacuum channels are adjacent said sacrificial material; and

using the vacuum channels to remove residual particles that remain in the image sensor after the step of removing the sacrificial material.

42. The method of claim 41 wherein the vacuum channels are formed prior to said step of removing the sacrificial material.

43. The method of claim 41 wherein said step of forming vacuum channels further comprises:

applying a vacuum photo resist to the first micro-lens array;

masking the vacuum photo resist and developing vacuum openings therein; and

etching the first micro-lens array through to the sacrificial material with a chemical etching solution.

44. The method of claim 43 wherein the chemical etching solution is an anisotropic etching solution.

45. The method of claim 31 wherein said removing the sacrificial material comprises treating the sacrificial material with chemical resist solvents.

46. The method of claim 31 wherein the support material is the first micro-lens material.

47. The method of claim 31 wherein the step of forming a second micro-lens array further comprises applying a second micro-lens material to the upper substrate layer and etching the second micro-lens material to form second micro-lenses.

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48. A method of fabricating an image sensor, the method comprising:

providing a substrate comprising a plurality of photosensitive regions having photo sensors, and an upper substrate layer
providing a color filter array on top of the upper substrate layer;
applying a sacrificial material to the upper substrate layer;
forming support molds in the sacrificial material;
forming lens molds in the sacrificial material;
forming supports by filling the support molds with a support material;
forming a first micro-lens array having first micro-lenses by filling the lens molds with a first micro-lens material; and
removing the sacrificial material.

49. The method of claim 48 wherein said step of forming the support molds further comprises:

applying a sacrificial photo resist to the sacrificial material;

applying a mask to the sacrificial photo resist and exposing support openings in the sacrificial photo resist; and

etching the sacrificial material by applying an chemical etching solution to form support molds by etching through the support openings.

50. The method of claim 49 wherein the chemical etching solution is an anisotropic etching solution.

51. The method of claim 48 wherein the step of forming the lens molds further comprises:

applying a sacrificial photo resist to the sacrificial material;

applying a mask to the sacrificial photo resist and exposing sacrificial resist openings in the sacrificial photo resist;

etching the sacrificial material by applying an chemical etching solution to form lens molds by etching through the sacrificial resist openings; and

applying a rinse to stop the etching process.

52. The method of claim 51 wherein the chemical etching solution is an isotropic etching solution.

53. The method of claim 48 wherein the step the forming the support molds further comprises etching the support molds in the sacrificial material by controlled laser etching.

54. The method of claim 48 wherein the step the forming the lens molds further comprises etching the lens molds in the sacrificial material by controlled laser etching.

55. The method of claim 48 wherein said sacrificial material degrades upon heating to a degradation point, and the step of removing the sacrificial material comprises heating the sacrificial material to at least the degradation point.

56. The method of claim 48 further comprising:

forming vacuum channels through the first micro-lens array, wherein the distal ends of the vacuum channels are adjacent the sacrificial material; and
using the vacuum channels to remove residual particles that remain in the image sensor after the step of removing the sacrificial material.

57. The method of claim 56 wherein the vacuum channels are formed prior to the step of removing the sacrificial material.

58. The method of claim 56 wherein the step of forming vacuum channels further comprises:

applying a vacuum photo resist to the first micro-lens array;
masking the vacuum photo resist and developing vacuum openings therein; and
etching the first micro-lens array through to the sacrificial material with a chemical etching solution.

59. The method of claim 58 wherein the chemical etching solution is an anisotropic etching solution.

60. The method of claim 48 wherein said removing the sacrificial material comprises treating the sacrificial material with chemical resist solvents.

61. The method of claim 48 wherein the support material is the first micro-lens material.

62. A method of fabricating an image sensor, the method comprising:

providing a substrate;

forming one or more supports having distal and proximal ends wherein the distal ends are proximate the substrate; and

forming a first micro-lens array supported by the supports at said proximal ends wherein a cavity is formed below said first micro-lens array and above said substrate.

63. The method of claim 62 further comprising the step of forming a second micro-lens array above the substrate and below the first micro-lens array wherein the distal ends of the supports are adjacent to the second micro-lens array and the cavity is formed above said second micro-lens array.